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Abstract

THE INFLUENCE OF d - c ELECTRIC FIELDS ON THE HEAT TRANSFER TO COOLING CO_2 AT HIGHER PRESSURES IN A NUCLEAR REACTOR

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The cooling gas which flows through the core of a nuclear reactor is partially ionized by radiation. A flow of ions perpendicular to the gas flow may be caused by the application of an electric field. As the concentration of ions in the gas volume is relatively high, it is possible to affect in this way the whole gas-stream and especially the heat-transfer from fuel elements to the gas. At the Second Geneva Conference we reported about experiments carried out with an electrically heated fuel element model cooled by air of atmospheric pressure. The possibility of heat transfer intensification by the application of an electric field in nuclear reactors was demonstrated by these experiments.

A series of experiments has since been performed in the gas-cooled loop of the Czechoslovak reactor VVRS, first with an electrically heated model and later with a rodtype uranium fuel element. The paper gives mainly the results of these last experiments, in which the pressure of the cooling carbon dioxide was changed from 5 to 30 kp/cm^2, and the voltage between the electrodes (one of which being formed by the uranium fuel element and the other by the channel wall) was changed from 0-30 kV. In addition to the influence of pressure and electric field strength the dependency of the effect on gas velocity, density of gas ionization and the polarity of the heat-exchanging surface was studied. The experiments resulted in the recognition of some new facts as well as in the broadening of previous knowledge.

It was established that by the action of a d - c electric field both an increase ("positive effect") and a decrease ("negative effect") of heat transfer to the gas may be obtained.

The influence of the electric field on heat transfer from the fuel element to the partially ionized gas differs principally whether the fuel element works as the cathode or as the anode.

With negative polarity of the fuel element the relative increase of heat transfer is highest at low pressures. The value of the relative heat transfer increase grows with increasing field strength and increasing density of gas-ionization. It decreases with increasing gas velocity and pressure. At higher pressures the positive effect changes to the negative one; the pressure at which this change occurs depends on the other determinant parameters.

With positive polarity of the fuel element no influence of the electric field on heat transfer was observed at atmospheric pressure. At lower gas pressures (5 kp/cm^2) a negative effect occurs. By raising the pressure further the effect may be transformed into the positive one. At higher pressures (15 kp/cm^2 or more) a considerable heat transfer increase may be obtained. The value of relative heat transfer increase grows again with increasing field strength and ionization density. It decreases with increasing gas-velocity, but contrary to the previous case it increases (in the studied range of pressures) with increasing pressure.

The maximum relative increase of heat transfer reached during these experiments amounted to about 50%. The maximum heat transfer decrease (negative effect) was about 15%. A more detailed description of the experiments, the magnitude of the effect as a function of the main parameters and an interpretation of the effect will be given in the paper.